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NEW HAMPSHIRE

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HANOVER N. H.,

BULLETIN NO. 11.

PIG FEEDING EXPERIMENTS.

PART 1. RESULTS OF FEEDING SKIM-MILK AND CORN MEAL VERSUS CORN MEAL AND MIDDLINGS.

PART 2. DIGESTION EXPERIMENTS.

NOVEMBER, 1890.

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

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FEEDING EXPERIMENTS WITH PIGS.

PART I.

G. H. WHITCHER.

The work reported in this Bulletin was designed to show something of the feeding or pork producing value of skim-milk, a matter of no small importance in connection with dairy farming. Within our state to-day there are probably 100,000 cows, producing 300,000,000 pounds of milk, of which about three-fourths, or 225,000,000 pounds, is made into butter. Now, on an average we get not far from eighty per cent of the whole milk as skim milk, consequently the annual quantity of skim-milk that the farmers of New Hampshire have to dispose of is 180,000,000 pounds, and if this is worth twenty-five cents per hundred it represents a value of $450,000.

While the original plan of these experiments covered only the financial side of the question, later it was found desirable to conduct digestion experiments to determine just how much of the food eaten was actually utilized by the pigs. This work was put into the hands of the Station chemist, Prof. Morse, whose report is to be found in Part II of this Bulletin.

The six pigs selected for this work were bought of a neighboring farmer, August 24, 1889, at which time they were six weeks old. While of no particular breed, they evidently had a good proportion of Chester White blood, and proved rapid growers and were remarkably uniform in shape and weight.

August 24 each pig was marked and his weight recorded, and at the same time they were divided into two lots as follows:

No. of Pig.	1	2	3	
Lot 1, live weight Aug. 24,	28	25½	28½	Total, 82
No. of Pig.	4	5	6	
Lot 2, live weight Aug. 24,	26	32½	25	Total, 83½

During the preparatory period, from Aug. 24 to Sept. 3, each lot received daily thirty pounds of skim-milk, and at the

last named date lot 1 weighed 96½ pounds, while lot 2 weighed 106 pounds.

PLAN OF THE FEEDING WORK.

To place the two lots on as equal a basis as possible it was decided that each should be fed a like amount of *digestible matter daily*, that is, the total amount of digestible albuminoids and non-albuminoids in the two rations should be as nearly alike as possible, but in one case the *source of this digestible matter* should be *skim milk* and *corn meal*, while in the other it should be *corn meal* and *middlings*, with water added. Of course the only possible basis upon which to compute such rations was the "feeding standards" and "feeding tables," and to utilize these it was necessary to assume that the skim-milk, corn meal and middlings were to be of average quality and digestibility. Luckily, subsequent analyses of the foods used, and determination of digestibility, did not show enough variation to affect the results in any way.

The amount of food required was estimated each week, from Wolff's "feeding standards," with a slight modification as to quantity. For one hundred pounds live weight there was feed daily an amount of food which would contain, for

Lot 1. { .536 lbs. albuminoids. / 3.36 lbs. non-albuminoids.

Lot 2. { .53 lbs. albuminoids. / 3.33 lbs. non-albuminoids.

Wolff's standard is { .40 of albuminoids. / 2.40 of non-albuminoids.

The ratio of albuminoids to non-albuminoids (nutritive ratio) is practically the same as Wolff's, but the total *digestible matter* daily for one hundred pounds live weight is 3.86 pounds as against 2.80. This excess is apparently greater than is actually the case, owing to the way in which the live weight was *estimated* in advance.

The pigs were weighed individually each week, and the ration for the succeding week was figured, not on the actual weight at the commencement of the week, but upon an estimate of what each lot would weigh at the end of the week; this was done by adding to the actual weight an amount equal to the *average gain of both lots* for the preceding week; as a matter of fact, therefore, the quantity of food was always figured for a

greater live weight than actually existed. A better way, doubt less, and one adopted in another experiment, would have been to have added *one-half* of this gain, thus figuring the ration on approximately the average live weight for the week. On the other hand, it may be reasonably urged that so long as the food was consumed without waste it was evident that these particular pigs, at least, were so constituted that they could handle more than Wolff's standards call for.

HOW THE RATIONS WERE COMPUTED.

As already mentioned, it was decided to make the grain ration a mixture of equal parts of corn meal and wheat middlings, as this mixture would have a nutritive ratio of 1 : 6.5, which was exactly what was desired. A sufficient amount was then taken to meet the requirements for the live weight involved, estimated as above explained.

The lot not having the mixed grain were to have such a mixture of skim milk and corn meal as should give exactly the same amount and proportion of digestible matter. It was found that one part of corn meal and two parts of skim-milk gave nearly the right proportion, or nutritive ratio, and in general this was the combination fed.

As the feeding progressed, samples of the foods were analysed, and when it was observed that the skim-milk ration invariably gave the greater growth, the digestibility of each constituent of the food was determined, as reported in Part II, where will be found the "Composition of Feeding Stuffs," Table I, page 11; "Composition of Dung," Table II, page 12; and Digestion Coefficients, Table IV, page 13.

The following table (I) is computed from the total composition and the digestion coefficients given in Part II, and is in the form which I have used for the last six years in feeding tables; the first column gives the digestible albuminoids, the second the non-albuminoids made up of digestible nitrogen-free extract, fibre and fat, the latter multiplied by 2½ to place it on a starch basis:

TABLE I.

100 pounds.	Digestible. Albuminoids.	Non-albuminoids.	Nutritive ratio.
Corn meal contain	7.92	76.91	1 : 9.7
Middlings contain	14.82	64.30	1 : 4.3
Skim-milk contain	3.29	5.82	1 : 1.8

In Table II are given the details of the rations used; the first, second and third periods are of twenty-one days each,

TABLE II.—Lot 1.

Period.	Week.	Live Weight.	DAILY RATIONS. Skim-milk.	Corn meal.	Middlings.	Water.	Gain, live weight	Gain per 100 lbs. live weight.	Ditto, averaged for period.	Cost of 1 lb. of gain, assuming skim-milk to be 25c. per cwt.	Ditto, averaged for period.	Digestible dry matter per 100 lbs. growth.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.			lbs.
1	1	96½	7	3½			12	11.7		.0306		
Sept.	2	108½	9	5			22	18.4	15.6	.0230	.0258	179
3 24.	3	13 ½	12	6			24	16.8	11.5	.0263		
2	4	154½		4	4	10	19	11.6		.0340		
Sept. 24	5	173½		5	5	10	22	11 9		.0365	.0380	271
toOct 15	6	195½		6	6	15	22½	10.9		.0430		
3	7	218	17	10			30½	13.1		.0327		
Oct. 15	8	248½	19	10½			28	10.7		.0375	.0350	243
to Nov. 5	9	276½	22	11			33½	11.4	11.7	.0344		
	10	310		9	9	*30	34½	10.4		.0420		
4	11	344½		10	10	34	28½	7.9		.0565		
Nov. 5 to	12	373		10½	10½	38	30	7 7	7.8	.0562	.0560	398
Dec. 10	13	403		10½	10½	38	27½	6.6		.0615		
	14	430½		11½	11½	37	27½	6.2		.0672		
	15	458	36	17			46	9.6		0396		
5	16	504	36	20		*2	49½	9.4		.0410		
Dec 10	17	553½	37	22		3	51½	8.9	8.5	.0425	.0434	304
toJan. 14	18	605	37	22		3	42	6 7		.0520		
	19	647	39	23		4	53	7 8		.0432		

TABLE II.—Lot 2.

		lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs	lbs			lbs.
1	1	106		2½	2½	6	8	7 3		.0503		
Sept.	2	114		3½	3½	8	16½	13.5		.0342	.0316	225
3-24	3	130½		4	4	10	26½	18.5	13.1	.0243		
2	4	157	12	6			16	9.7		.0394		
Sept. 24	5	173	14	8			31½	16 6	15.3	.0256	.0270	189
toOct. 15	6	204½	16	10			42	18.6		.0233		
3	7	246½		7	7	16	25	9.7		.0452		
Oct. 15	8	271½		7½	7½	18	24½	8.7	9.2	.0493	.0460	328
to Nov. 5	9	296		8	8	20	29	9.3		.0445		
	10	325	27	14		*6	50½	14 4		.0287		
4	11	375½	30	16		7	40½	10.2		.0406		
Nov. 5 to	12	416	33	18		8	41	9.5	11.1	.0448	.0363	252
Dec 10	13	457	33	18		8	41	8.6		.0448		
	14	498	36½	19½		8	68	12.8		.0295		
	15	566		14	14	46	34½	5.9		.0650		
5	16	600½		15	15	45	45	7.2		.0537		
Dec. 10	17	645½		16	16	48	41½	6.2	5.3	.0620	.0633	450
toJan. 14	18	687		16	16	48	27½	3.9		.0936		
	19	714½		8½	8½	25	25½	3.5		.0502		

*Extra water in both lots.

while the fourth and fifth are of thirty-five days each. The lots were alternated from the skim-milk and corn meal ration to the mixed grain ration, and *vice versa* at the beginning of each period, thus equalizing any variation in the natural thriftiness of the two lots.

Table II is arranged as follows: Commencing at the left the first column gives the period and date covered; the second column gives the number of the week since the experiment commenced; the next four columns give the kind and amount of food fed per lot daily; the gain per week for each lot comes next; then the gain figured to one hundred pounds of live weight, followed by the same averaged for the entire period; in the next column is given the cost per pound of growth for each week. In order that this might be figured out it was necessary to assume some value for skim-milk, and I have taken this at twenty-five cents per hundred pounds; following this is the average per period.

This table contains the more important results of the experiment. The most noticeable thing about it is the superiority of the skim-milk and corn meal ration over that made up of corn meal and middlings, notwithstanding the fact, as will be shown later, that the former ration did not contain as much digestible matter as the latter.

Table III is condensed from Table II for the purpose of showing that this superiority is a decided one, both as to rate of growth and cost of growth.

TABLE III.

Period.	LOT ONE.				LOT TWO.			
	Average gain per week for each 100 lbs. live weight.		Average cost per pound of growth.		Avearge gain per week for each 100 lbs. live weight.		Average cost per lb. of growth.	
	Skim-milk.	Mix'd grain.	Skim-milk.	Mix'd grain.	Skim milk.	Mix'd grain.	Skim-milk.	Mix'd grain.
	lbs.	lbs.	cts.	cts.	lbs.	lbs.	cts.	cts.
1	15.6		2.58			13.1		3.16
2		11.5		3.8	14.9		2.70	
3	11.7		3.50			9.2		4.60
4		7.8		5.6	11.1		3.63	
5	8.5		4.34			5.3		6.33

A glance will show that the growth per one hundred pounds of live weight is much larger in each lot when the ration is skim-milk and corn meal than when it is corn meal and middlings, and it is likewise noticeable that this gain decreases with the same ration as the *pigs grew older*. It is also evident that the cost of growth follows the same rule, being lowest when the gain is greatest.

The following averages were obtained during the one hundred and thirty-three days covered by this work:

	Lot 1.		Lot 2.	
Average weekly gain for 100 lbs live weight, on skim-milk ration,	**11.3**	10.4	**12.5**	10
on mixed grain ration,	9.2		8.5	
Average cost of 1 pound of growth, on skim-milk ration,	**3.9**	4.4	**3.4**	4.5
on mixed grain ration,	5.1		5.3	

The figures for the skim-milk and corn meal ration are put in black faced type, and it is at once seen that the rate of gain is unmistakably greater on the skim-milk and grain than on grain alone, the percentage in favor of the former being 23 and 47 on lot 1 and 2 respectively, while the cost of growth on lots 1 and 2 is 1.2 cents and 1.9 cents greater per pound when the food was mixed grain; this difference is well worthy of careful consideration. With grain costing, as this did, $20.00 per ton for corn meal and $26 for middlings, such pigs as these were cannot be fed without loss when pork sells at four cents alive, or five cents dressed.

With skim-milk, however, the case is different, for two reasons: first, less "raw material," that is digestible matter, is required to produce a pound of growth, as shown below.

DIGESTIBLE MATTER PER HUNDRED POUNDS OF GROWTH.

Average digestible dry matter required to produce 100 pounds gain:	Lot 1.	Lot 2.
Skim-milk and corn meal,	242	220½
Meal and middlings,	334½	334½
Average for entire time,	279	288¾

and secondly, because with skim-milk and corn meal a greater quantity of food can be handled daily. Thus, by both of these factors the time required for producing a two hundred pound pig is reduced very materially. This point is not sufficiently

appreciated by many who feed pigs. With the present prices there is but one way in which pork can be produced at a profit, and that is by producing a two hundred pound pig in the shortest possible time.

We see from Table II that the cost of growth and the amount of food required to produce one hundred pounds of growth increase as the pigs grow older, and it would have been much more profitable to have sold them when averaging one hundred and seventy-five pounds each than when averaging two hundred and forty pounds.

Thus far we have, for convenience, figured all results on the assumption that the skim-milk used was worth twenty-five cents per hundred pounds.

We will now see what its value actually was under the conditions of this experiment, the price of live hogs being four cents per pound, and the cost of grain as previously mentioned.

For our present purpose we will neglect the first cost of the pigs and note the value of the *gain of live weight* for each period, where skim-milk was used as a part of the ration.

TABLE IV.

Period.	LOT ONE.					LOT TWO.				
	Value of gain for period, @ 4c. lb.	Value of corn meal fed.	Value of skim-milk by difference	Amount of skim-milk fed.	Value of skim-milk per 100 lbs.	Value of gain for period, @ 4c. lb.	Value of corn meal fed.	Value of skim-milk by difference	Amount of skim-milk fed.	Value of skim-milk per 100 lbs.
	$	$	$	lbs.	cts.	$	$	$	lbs.	cts.
1	2.32	1.01	1.31	196	67					
2						3.58	1.68	1.90	294	64½
3	3.68	2.20	1.48	406	36½					
4						9.64	5.98	3.62	1116	32½
5	9.68	7.28	2.40	1295	18½					
To'l	15.68	10.49	5.19	1897		13.22	7.66	5.56	1410	
Av.					27½					39½

This table is constructed by determining the value of the gain for each skim-milk period and subtracting therefrom the cost of the corn meal which was fed with the skim-milk, the remainder represents the value of the skim-milk, which, divided by the amount gives the value per hundred pounds. The showing is certainly a favorable one, and with thrifty pigs from twenty

to thirty cents per hundred ought to be and can be realized for skim-milk, when live hogs sell at four cents per pound. It must be constantly kept in mind, however, that they must be sold by the time they reach a live weight of from two hundred to two hundred and thirty pounds.

FEEDING WITH GRAIN ALONE.

Table V gives the results of feeding with corn meal and middlings.

TABLE V.

	LOT ONE.			LOT TWO.		
	Value of gain, @ 4c. per lb.	Cost of grain fed.	Cost of gain per lb.	Value of gain, @ 4c per lb.	Cost of grain fed.	Cost of gain per lb.
	$	$	cts.	$	$	cts.
1				2.04	1.61	3.1
2	2.54	2.41	3.8			
3				3.14	3.61	4.6
4	5.92	8.29	5.6			
5				6.96	11.02	6.3
Total	8.46	10.70		12.14	16.25	
A v'ge			5.0			5.3

This table seems conclusive, so far as these pigs were concerned, and we are obliged to say that on grain alone there was a loss of more than one cent for every pound of growth.

These results show us that we cannot blindly follow the teachings of feeding tables, for should we so do one of these rations would be as good as the other, but as a matter of fact, while chemically the skim-milk ration was not quite as rich in nutritive material as the grain ration, yet the former was, on an average, thirty per cent. more efficient in actual results than the latter.

PART II.

DETERMINATION OF DIGESTIBILITY OF RATIONS.

F. W. MORSE.

The comparative digestibility of the two rations was determined as follows:

One pig from each lot was taken and placed in a box or cage, so constructed that the food would not be wasted and none of the dung would be lost.

The pigs did not seem to mind this confinement and continued to gain in weight as before the beginning of this part of the experiment. Fortunately, the weather was mild and no wide variation in temperature occurred during this period.

The food for each was weighed night and morning and samples taken at each weighing for subsequent analysis. Equal parts of the morning and evening samples of skim-milk were mixed together and analysed on the following day, before it became sour. Equal parts of the daily samples of corn meal and middlings were mixed together, and at the close of the experiment a small sample was drawn from each for analysis. By this means the average composition of each food stuff was determined. This composition is given in the following table:

TABLE I.

	Water.	Dry matter.	Ash.	Ether extract.	Crude protein.	Crude fibre.	Nitrogen-free extract.
Corn meal,	14.22	85.78	1.71	3 85	9 23	1.54	69.45
Middlings,	12.30	87 70	3.09	3.89	16.75	2.67	61.30
Skim-milk,	90.61	9.39	0.77	0.33	3.29		5.00

The pigs were carefully watched, both day and night, and the dung was collected and put into glass jars. The dung was weighed each day, and at the close of the period was placed in a large porcelain dish and dried as quickly as possible, until it

was in a condition to be mixed together thoroughly, when a small sample was taken for an analysis.

The composition of the dung of each pig is shown in the following table:

TABLE II.

	Water.	Dry matter.	Ash.	Ether extract.	Crude protein.	Crude fibre.	Nitrogen-free extract.
Pig A,	68.55	31.45	4 41	2.43	6.62	4 28	15.71
Pig B,	67.14	32.86	7.11	3.86	8.24	2.93	10.72

During the digestion period Pig A consumed twenty-two pounds and five ounces of corn meal, twenty-two pounds and five ounces of middlings, together with eighty-four and one-half pounds of water, and voided ten pounds and ninety-three one-hundredths of dung.

Pig B consumed forty-two pounds of corn meal, seventy-seven pounds skim-milk, and twenty-one pounds of water, and voided six pounds and sixty-seven one hundredths of dung. From these figures and the composition of the food stuffs and dung, is calculated the following table, showing the amount of each nutrient eaten, voided and digested; the amount digested being the difference between the amount eaten and the amount obtained in the dung.

TABLE III.

	PIG A.			PIG B.		
	Consumed.	Voided.	Digested.	Consumed.	Voided.	Digested.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Water,	90 41	7.49		96.74	4.48	[illegible]
Dry matter,	38.71	3.44	35.27	43.26	2.19	41.07
Ash,	1 07	.48	.59	1.31	.47	.84
Ether extract,	1 63	.26	1.37	1.87	.26	1.61
Crude protein,	5.80	.72	5.08	6.41	.55	5.86
Crude fibre,	.94	.47	.47	.65	.19	.46
Nitrogen-free extract,	29 17	1.72	27 45	33.02	.71	32.31

By this table it is shown that Pig B, on the skim-milk ration, consumed more food than Pig A, and digested more of each nu-

trient. This difference amounted in all to five and eight-tenths pounds of dry matter. He also gained two and twenty-five one-hundredths pounds more in live weight than Pig A.

The pigs were weighed each day, at the same hour, and showed a continued increase in weight, amounting in all to three and seventy-five one-hundredths pounds for Pig A, and six pounds for Pig B.

Pig A did not eat readily, and on two occasions his daily rations had to be reduced below that originally planned for him. Pig B ate freely at each feeding and consumed the full ration planned for the experiment, and apparently would have eaten more if it had been given him. This fact was probably owing to the greater digestibility of the ration.

This greater digestibility of the skim-milk ration was noticeable for each nutrient; but especially so for the crude fibre, as the following table of percentages of digestibllity will show:

TABLE IV.

	Dry matter.	Ether extract.	Crude protein.	Crude fibre.	Nitrogen-free extract.
Pig A,	91.11	84.04	87.58	5 .00	94.10
Pig B,	94 93	86.09	91.4 :	70.77	97.85

To be sure the crude fibre does not occur in large quantities in the food of pigs, yet there was a difference in the dung of the two pigs, apparent to the eye. The dung from Pig A was dry and hard and contained many undigested hulls or scales from the middlings and corn meal, while Pig B passed a soft dung.

The nutritive ratios calculated from the actually digested nutrients vary but slightly in the two rations, being 1 to 6.17 for the corn meal and middlings, and 1 to 6.27 for the corn meal and skim-milk.

CONCLUSIONS.

1. For each one hundred pounds of live weight eight pounds of skim-milk and four pounds of corn meal make an ample and well proportioned daily ration.

2. In the absence of skim-milk, two and one-half pounds of corn meal, two and one-half pounds of middlings, and eight pounds of water, will give an equal amount of nutritive matter.

3. One hundred pounds of digestible matter in the skim-milk and corn meal ration was equal to one hundred and forty-six and six-tenths pounds in the corn meal and middlings ration.

4. The superiority of the skim-milk ration is due in part, doubtless, to its greater digestibility; but still more, in my opinion, to the fact that there is less waste matter, that is indigestible matter, to be carried through the system, and to the noticeable difference in the character of the dung, mentioned by Prof. Morse in Part II of this Bulletin. The pigs, on mixed grain invariably grew constipated, while those on skim-milk was not so affected.

5. The cost of a pound of gain on skim-milk and corn meal was three and six-tenths cents, on mixed grain ration, five and two-tenths cents.

6. Digestible dry matter required to produce one hundred pounds of gain of live weight on skim-milk and corn meal, two hundred and thirty-one pounds, on mixed grain, three hundred and thirty-four and one-half pounds.

7. { Lot 1, when dressed, shrunk 19.6%.
   { Lot 2, when dressed, shrunk 18.4%.

8. Calling skim-milk worth twenty-five cents per hundred and we get the following balance sheet, on the basis of the cost as given in "Conclusion No. 5:"

30 lb. pig, first cost,	$2.00
170 lbs. of growth on *skim-milk and corn meal*, @ 3.6 cts.,	6.12
200 lb. pig cost,	$8.12

which equals **4.06** cents per pound.

30 lb. pig, first cost,	$2.00
170 lbs. of growth on *corn meal and middlings*, @ 5.2 cts.,	8.84
200 lb. pig cost,	$10.84

which equals **5.42** cents per pound.

G. H. WHITCHER, *Director.*

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